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INTERNATIONAL PROGRAMS

International cooperation in an important dimension of NASA's program. From the first year, when the United States invited foreign scientists to propose experiments for launching, an extensive program of international cooperation involving more than 1,000 projects with over 100 countries has opened the entire range of space activities to foreign participation, has demonstrated the many peaceful purposes and applications of space science and technology, and has provided opportunities for contribution by scientists and agencies of other countries.

The programs fall into two categories: cooperative and reimbursable. The cooperative activities include contributions of experiments on payloads to be flown in space by NASA, joint projects to develop flight hardware, analysis of data provided by NASA spacecraft, training, visits, and joint publication of scientific results.

On a reimbursable basis NASA also provides services for which the user country pays; these range from space launch services to data and tracking services. NASA maintains a number of foreign tracking stations overseas, which have been indispensable for the acquisition of data from many scientific and applications satellites.

Over the years, NASA's wide range of cooperative and reimbursable programs has benefited both the U.S. and the international community. Since 1962, over 40 cooperative satellites have been placed in orbit, and since 1965, more than 60 reimbursable satellite launches have been completed. In addition, there have been over 2,000 joint ground-based and space research activities, including sounding rocket, balloon, data investigations, and space science experiments.

Evaluation of an Instructional Computing Inservice Course for Elementary and Middle School Teachers

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Our society has become increasingly conscious of the coming age of the microcomputer as an educational tool of great potential. Both elementary and secondary schools are purchasing microcomputers at a rate that suggests that in the near future providing children access to a microcomputer will no longer be a major problem (School Uses of Microcomputers, 1983). Many teachers, realizing that they need specific training to use microcomputers in the classroom, seek help from colleges and universities in the form of computer-related courses. Enrollment in these classes will probably continue to increase in the foreseeable future. The development and improvement of inservice (and preservice) courses in instructional computing has much to gain from the discussion in the mathematics education literature of theoretical orientations and evaluations of already implemented courses. The purpose of the present study is to evaluate an instructional computing inservice course conducted at the University of Georgia.

In developing this course we faced two basic issues. First, how quickly and to what extent will access to microcomputers bring about major changes in the actual content of school mathematics? Second, within a given curriculum, what is the appropriate instructional role of the microcomputer? The answers to these two questions form the basis upon which to develop any instructional computing course.

At present, student use of computers is often seen as something to be added to an already crowded curriculum. This is one possible explanation for the reported emphasis on using microcomputers for drill and practice (School Uses of Microcomputers, 1983). Although we are concerned that this utilization of computers is short-sighted, we also realize that present curriculum guidelines are exerting pressure on teachers to improve scores on standardized tests, which tends to translate into drill and practice usage of microcomputers. Therefore, what we may teach at the university pertaining to alternate uses of microcomputers will not be implemented to a great extent in the schools unless corresponding curriculum changes are also forthcoming.

We believe that school mathematics instruction should place a greater emphasis on process aspects of mathematics such as problem solving, applications, and development of computing algorithms (College Board, 1983; NACOME, 1975; NCTM, 1980). In such situations, the primary roles of the microcomputer are to allow students to create programs (student programming), to explore mathematical concepts and procedures, and as an aid in the solution of mathematical problems. Drill and practice becomes subsidiary to student programming and would be mainly used for remediation and review.

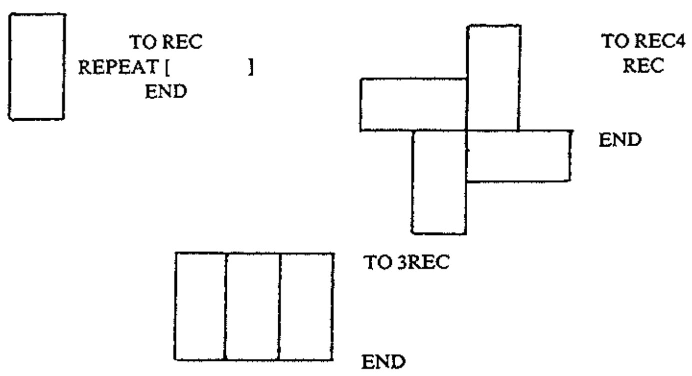
We also believe that major changes in the school mathematics curriculum are inevitable but these changes will be slow in coming. Teachers attending instructional computing courses will be the agents of change, yet at the same time they must continue teaching in a product-oriented system. Therefore, while emphasizing to teachers the powerful idea of having their students write programs and in so doing explore creatively some mathematics at their own level, we included in the course software evaluation and discussion of drill and tutorial programs. We chose Logo as the primary language of the course because we felt it affords elementary and middle school students the most direct avenue into the realm of programming. We also included some rudimentary instruction in BASIC because of its pervasiveness in the schools.

In our evaluation of the course we were concerned mainly with its immediate and lasting effects on teachers' views (and practices) as to the appropriate role of microcomputers in the classroom. Other aspects of interest were the effects of the course on teachers' programming knowledge and mastery of selected mathematical concepts.

It may be argued that elementary and middle school teachers should become knowledgeable consumers of ready-made software rather than programmers. To ascertain to what extent teachers could create programming related materials with classroom application we decided to assess their programming knowledge and skills. Furthermore, because elementary and middle school teachers sometimes have detectable weaknesses in their mathematics background we also attempted to investigate if incidental learning of selected mathematical concepts was stimulated by the tasks worked throughout the course. The concepts of randomness, expected value, and variable were used for this purpose, because they are related to various aspects of computer programming.

FIGURE 1(a)
LOGO WORKSHEET I

Complete the REC program and use it to draw REC4 and 3REC



Construct a STEP program and use it to make L. STEP, STAIRS, and SPIN

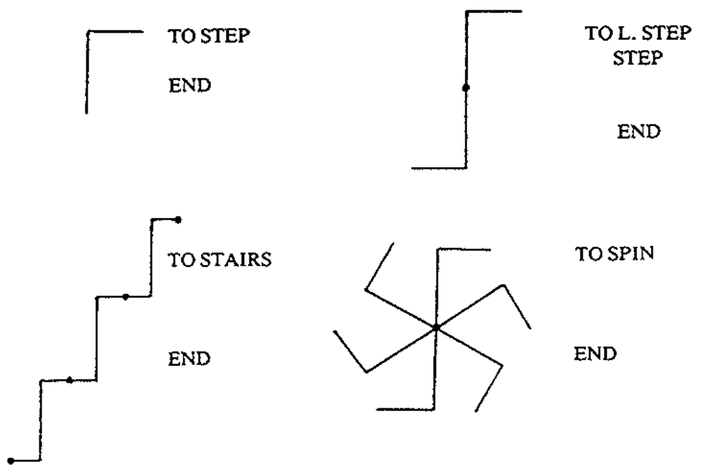
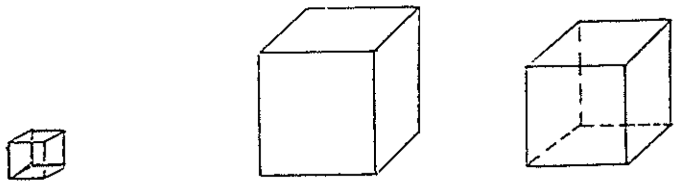


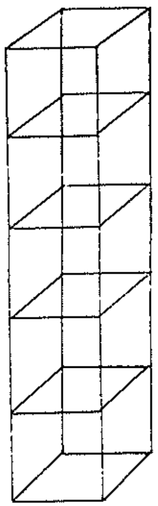
FIGURE 1(b)
LOGO WORKSHEET 2

1. Write a master program that will draw a variable solid cube.
   S.CUBE :X
2. Modify this program to create a glass cube.
   G.CUBE :X
3. Modify this program to product a technically drawn cube.
   T.CUBE :X



G.CUBE 10 S.CUBE 40 T.CUBE 30

4. Create a block tower of glass cubes



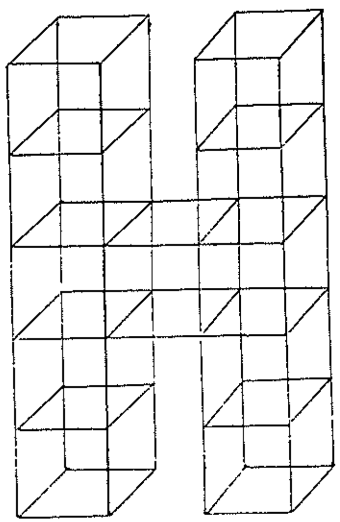
TOWER :X :N

where :X is the size of each cube

and :N is the number of cubes

5. How about a glass H?

H :X



The Inservice Course in Instructional Computing

The course consisted of a two-week class given during the summer of 1983. Class sessions were conducted by one university faculty member and four graduate assistants and included demonstrations of Logo and BASIC commands with follow-up assignments requiring applications of these commands. These assignments were often administered as worksheet prototypes for elementary school students (see Figure 1 for a sample assignment). Due to the very low student/instructor ratio individualized assistance was widely provided.

". . . improvement in the knowledge of programming and selected mathematical concepts were assessed . . ."

Class sessions also included previews and critiques of commercial software, instruction and practice in word processing, discussions of issues raised in Papert's (1980) *Mindstorms*, demonstrations with a programmable turtle-like machine, working through a tutorial workbook on Logo, and modifying and extending instructor supplied programs. Participants were paired by grade level and assigned to an Apple II + microcomputer for 10 three-hour class meetings. Outside classwork was usually done individually for approximately two hours per day. One major requirement of the course was the development of a project consisting of computer related materials to assist instruction in the teachers' classroom within the existing curriculum.

Subjects

The 14 participants were 9 elementary and 5 middle school teachers selected on a first-come first-served basis from responses to announcements sent to curriculum directors in six counties in Georgia—one containing a small city and five neighboring rural counties. Their teaching experience ranged from 1 to 21 years with a median of 4 years. Also enrolled in the course were 4 secondary school and 2 college teachers not considered for the purpose of this evaluation.

Instruments

Teachers' views concerning the instructional uses of microcomputers were analyzed through their projects. Other aspects of teachers' attitudes towards microcomputers and improvement in the knowledge of programming and of selected mathematical concepts were assessed through pre- and post-tests. An attitudes test and an algebra/probability test in a multiple choice format were administered using a microcomputer. A geometry test and a programming test had a multiple-choice paper-and-pencil format. A questionnaire-survey was also developed to follow-up teachers' actual classroom practices and views after a six-month period had elapsed.

The test on programming concepts had 12 items. Three of these items were intended to assess proficiency in tasks dealing with the general logic of programming. The other items were related to concepts, procedures, and statements used in Logo and BASIC. The reliability of this test (alpha coefficient, Thorndike, 1982) was .53 in the pre- and .74 in the post-test. The algebra/probability test had five items on the notion of randomness and expected value and five on the notion of variable. The reliability of this test was .53 in the pretest and .51 in the post-test. The geometry test was a 20-item criterion-referenced test for which the mastery level was fixed, following the recommendations of a panel of six mathematics educators, at 17 items correct. This test included eight items dealing with the coordinate plane and 12 items dealing with angles, motions, and shapes.

Results

Teachers' views on uses of microcomputers

The projects developed by the teachers took various forms—original programs, assignments and worksheets for students, and supplying content to existing utility programs. Given the nature of Logo and the examples of student programming tasks presented in class, it was expected that a considerable number of the projects would involve student programming activities. This was not the case. Table 1 summarizes the instructional purpose of various projects developed by the seven elementary and middle school teachers that were completed by the time of writing this report. Each project contains one or more of the following components. Utility components involved constructing sets of reading and mathematics words and creating definitions, hints, and incorrect spellings to be incorporated into existing drill and practice commercial programs. Drill components called for students to reply with memorized responses to mathematics and language arts questions. Projects with computational components required children to perform arithmetic procedures. Tutorial components presented mathematics and language arts information and questions, usually combining text and diagrams. Problem solving components dealt with concept identification tasks in graphic settings. Programming components presented tasks to students and called on them to respond by giving programming instructions to the computer.

An examination of Table 1 indicates considerable attention to drill components. Six of the seven projects developed by elementary school teachers contained drill components. Two elementary and two middle school teachers included programming components. The programming tasks called for by the elementary school teachers were all in Logo's Immediate Mode and asked students to instruct the computer to draw straight lines (angles, segments, rays). In contrast, programming tasks called for by middle school teachers asked students to create programs in the Logo's Edit Mode and required construction of complex figures and translations, rotations, and reflections of these figures. Students were also asked to generate graphic examples of equivalent fractions. We judged

TABLE 1
Types and frequencies of instructional components in teacher projects

	Teachers in Grades 1-5 N = 7	Teachers in Grades 6-8 N = 5
Utility	2	0
Drill	6	2
Computation	2	2
Tutorial	2	1
Problem Solving	1	2
Programming	2	2

the use of programming in the middle school teachers projects as more substantial. Still, less than half of the middle school teachers decided to use a programming component in their projects.

Most teachers revealed in the beginning of the course highly positive attitudes concerning the educational potential of microcomputers. But several aspects of their views seemed to change as a consequence of the course. Initially three teachers considered a suitable arrangement for their schools the allocation of a single computer for each wing or section of the school. By the end of the course each of these teachers felt that they would need a computer in their own classrooms. Six other teachers indicated both in the beginning and in the end of the course that the existence of several computers in each classroom would be the ideal solution.

Some teachers viewed microcomputers essentially as a means of motivating the students (seven responses at the beginning and five at the end of the course). Student programming was elected as the main reason to introduce microcomputers in schools by just two teachers at the beginning and three at the end of the course. Drill-and-practice was selected in both instances by three elementary school teachers.

Most teachers felt that students should work with computers once a day (nine responses both at the beginning and at the end of the course). A small number advocated either a greater (three) or a lesser (two) use of computers by students.

In the beginning of the course five teachers indicated that the principal reason why students should learn to write computer programs was because programming teaches logical thinking. This number increased to nine by the end of the course. Other reasons pointed out were that programming provides a creative outlet and it is a part of computer literacy—both chosen by four teachers at the beginning and by two at the end of the course.

Describing their abilities, some teachers who initially declared themselves as either skilled or as marginal, labeled themselves as intermediates by the end of the course. It seems that while some gained confidence in working with microcomputers others became conscious of the real limits of their knowledge.

Positive feelings about the implementation of computers in their classrooms increased. Some initial insecurity revealed by four teachers disappeared by the end of the course, replaced by a general feeling of excitement.

Programming and mathematics

The mean scores in pretests and post-tests for the programming and algebra/probability tests are shown in Table 2.

TABLE 2
Mathematics and programming tests: Means and standard deviations in pre- and post-tests; computed t-values and p-values for the test of no difference.

	Pretest	Post-test	t-value
	M SD	M SD	t (computed) p-values
Algebra/Probability (10 items)	7.57 1.83	8.71 1.20	1.88 0.038
Programming (12) items	6.77 1.96	8.23 2.42	1.624 0.062

Only 13 teachers took both the pre- and post-test on programming concepts. In this test the mean gain score was 1.5. There were two negative gain scores, two null gains, and nine positive gains. A matched pairs t-test (Lindgren, 1976) indicated that this result was statistically significant with $p < .07$. The most progress was noted on the items related to Logo. General programming items also showed some improvement but there was only a little progress on the items concerning BASIC.

In the algebra/probability test the mean gain score was about 1.2. Most of the teachers scored high in the pretest but even so there was noticeable improvement especially in the items on randomness. A matched-pairs t-test indicated that this gain score was statistically significant with $p < .04$.

Only 12 of the teachers in the sample took both the geometry pre- and post-test. Six of them achieved mastery in both tests. The other six were all non-

masters on the pretest. Of these, five achieved mastery on the post-test. Difference scores in the pre- and post-test showed a marked variability (three were negative, two zero, and seven positive) with teachers with lower scores in the pre-test having the highest gains.

Questionnaire

The results of the questionnaire-survey indicated that in actual practice most of the teachers in the course had difficulties in implementing instructional computing in their classes due in large part to limitations in the computing resources available in their schools. Roughly half of the teachers in the course were not using computers in their teaching. The survey revealed either their schools had not yet acquired computers or had so small a number that teachers in the lower grades did not have access to them. In this respect there was a sharp contrast between the rural schools and the city schools. While computers in the rural schools were almost nonexistent, the city schools seemed to have enough to begin offering students some instructional computing activities.

But even the teachers who were using microcomputers did so in a restricted way, due to the small number of computers available, the lack of appropriate software (only one school had the Logo language), and the absence of adequate curricular, technical, and administrative support.

Generally in the classes using computers, students had rather sparse contact with them (1 to 4 times a month). The most common computing activities were introduction to computers and drill-and-practice. An exception to this pattern of computer use was a middle school teacher who had reserved one of the school's three computers for exclusive use during a two-week period for intensive work with microcomputers. However, this was the first extensive use she had made of the computer in the six months since resumption of school in the fall. She was using the microcomputer in a variety of applications, from drill-and-practice to programming and educational games.

Programming activities had been used by three teachers. Problem solving, while still considered as a desirable use of microcomputers by most of the teachers, had so far only been implemented by one of them.

Discussion

The course appeared to be effective in helping teachers develop their programming skills and become aware of the range of instructional applications of the microcomputer. Teachers coming to this program already had a strong motivation about the use of microcomputers. However, the course seemed to reinforce this motivation, which supports the view that teachers can develop positive attitudes towards the use of microcomputers (Bell, 1979; Vensel, 1981).

The orientation toward drill on the projects developed by a considerable number of teachers was surprising in light of the presentation of Logo as a programming language for children and the numerous examples of Logo programming activities presented to these teachers. However, the attraction of the elementary school teachers in this study to drill activities is consistent with the findings of a national survey (School Uses of Microcomputers, 1983). The attraction to drill and computation may reflect the initial role that teachers see for computers in schools or may reflect their conception of the mathematics curriculum. These teachers may have been anxious about using newly acquired programming skills and found drill activities easy to conceptualize and construct.

Noticeable progress in teachers' programming skills was indeed apparent from the projects. The relatively high pretest scores on the programming test indicated these teachers came to the course with a reasonable facility to write programs. Still some improvement of the understanding of the conceptual aspects of the logic of programming was apparent from teachers' performances on the programming test.

Though no teaching directly addressed mathematical content, the improvement on the scores on the algebra/probability test suggests that intensive work in computer programming may enhance inservice teachers' ability to deal with selected mathematical concepts. The results of the geometry test suggest that the course was especially helpful for teachers less prepared in geometry.

In designing an instructional computing course for teachers one faces the problem that the purpose and application of computers in schools cannot be fully apprehended by teachers who are not confident in programming. The course was effective in promoting in the teachers the skill, self-confidence, and motivation to use computers in their classrooms but we feel that our objectives regarding the instructional values of student programming were not highly successful. For two weeks teachers worked intensively with microcomputers and created programming related materials. Future versions of the course should try to address this problem in new ways. Two possibilities include changing the format to two distinct one-week sessions or several weekend sessions thus allowing more time for reflection and consolidation of the acquired programming skills, and requiring as course assignments the development of sample student programming tasks for the existing curriculum.

The teachers seemed to be confident about computers and desired to use them in their teaching. However, the limitations in computing resources, and notably the nonavailability of computers or of the Logo language highly restricted their possibilities. In the absence of effective support and supervision most of the implemented computer use followed the traditional lines of computer literacy and drill-and-practice. However, lasting effects of the course could be traced to some programming and problem solving activities used by some middle school teachers.

This inservice course for elementary and middle school teachers was developed to a large extent in a Logo oriented environment. The teachers participating in the course were successful in creating Logo programs. The course appeared to foster growth in certain mathematics concepts and reinforce positive views about the instructional use of computers. However, our observations six months after the end of the course seem to suggest that the implementation of instructional computing stressing the educational role of student programming and problem solving requires effective and ongoing support from curriculum coordinators and school administrators.

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BIG FURROWS A MYSTERY

Huge furrows, two to three feet deep, 15 to 20 feet across and miles long are found in Lake Superior (as in ocean sediments) but little is known about them. A joke has it that they are parallel tracks of "submarine tires." Theory, however, suggests that bottom-sweeping currents shaped these furrows just as wind and water shaped land forms.